



Halliburton Dual Fuel System

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DID YOU KNOW

SOMETIMES THE MOST IMPORTANT WORK
YOU CAN
DO IS TO **STOP WORKING**

If you're working and you see a process that is not being followed correctly, or if you notice at-risk behavior going on, take the initiative and call a quick time-out. Then confer with your workmates to make sure everyone knows the safe way to continue.

Executing Stop Work Authority to right safety wrongs and catch potential unsafe action before it actually happens is not only responsible, it's also effective. In fact, in the oil and gas industry, it's been one of the most successful approaches to safety in the last decade.

Empower the people around you. Encourage them to watch for unsafe conditions or processes, and when it's necessary, stop the job until it can be done safely.

At Halliburton, solving customer challenges is second only to keeping everyone safe and healthy. You can find more safety tips at www.halliburton.com/HSE.

Safety Moment Subject suggested by: Brent Johnson, *Halliburton Employee*



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Dual Fuel Background

Drilling Engine Application

- 2-3 Engines
- Lower Horsepower
- Constant Load & Speed
- Stationary



Mobile Frac Application

- 8-18 Engines
- Higher Horsepower
- **Variable** Load & Speed
- **Mobile**



Natural Gas Opportunities



CNG
Compressed Natural Gas



LNG
Liquefied Natural Gas

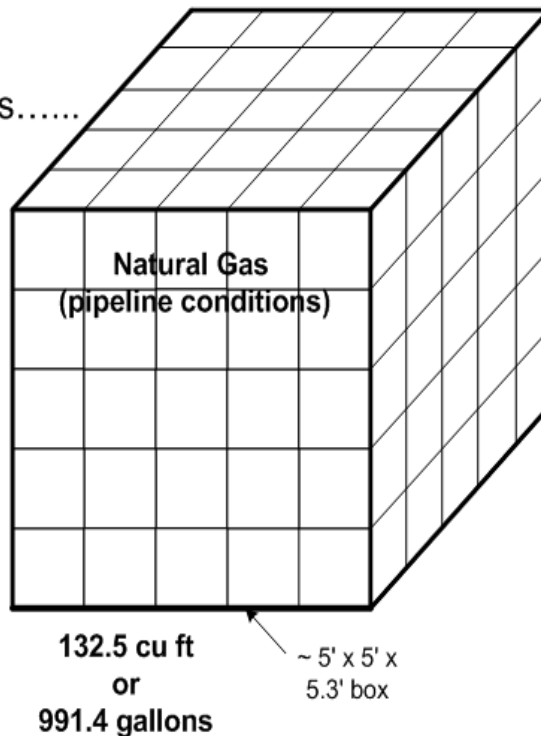
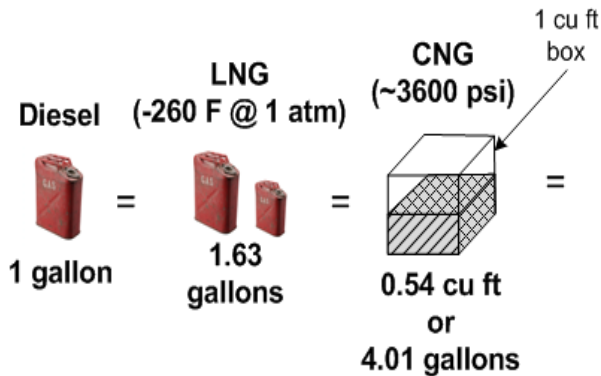


Conditioned
Field Gas

Energy Equivalency

1 gallon Diesel = 129,488 BTU

On an equivalent Energy Content Basis.....



Fuel	US\$/DGE
Diesel	3.50 – 3.75
LNG*	2.00 – 3.15
CNG*	1.15 – 2.30
Nat Gas	0.45 – 0.50

*Does not include transportation and labor costs

Pipeline/Conditioned Field Gas

- Typically 850-1250 BTU/cuft content (80MN)
- Although no transport costs, there are potential conditioning costs for field gas
- ~1 MMSCF/Day to power 20k HHP spread (**9,000 SCFH per 2,000 hhp unit**)



CNG

- Stored at 3,000-4,000 psi
- Pressure must be reduced before usage
- CNG tube trailer ~ 110,000 SCF = 830 DGE
- **One CNG tube trailer can power two 2,000 hhp units for 6 hrs**



LNG

- Stored at -260F
- Same natural gas properties after vaporization
- 'Queen' storage trailer: 14,000 LNG gal = 8,590 DGE = 1.1MMSCF
- **One LNG queen storage trailer can power 10 pumps for 13 hours**



Diesel

- Typical transport size ~4,000 gal
- **Powers 10 pumps for 4 hours**



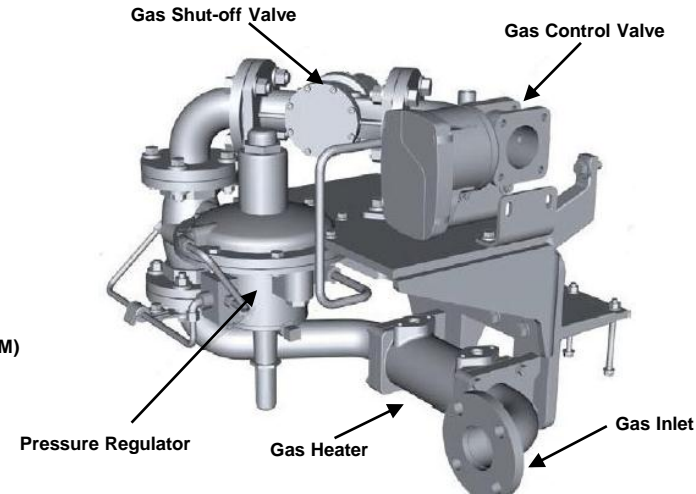
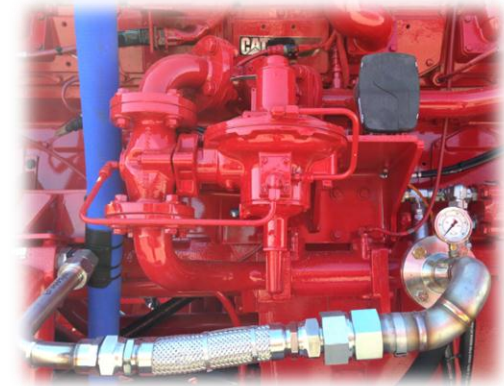
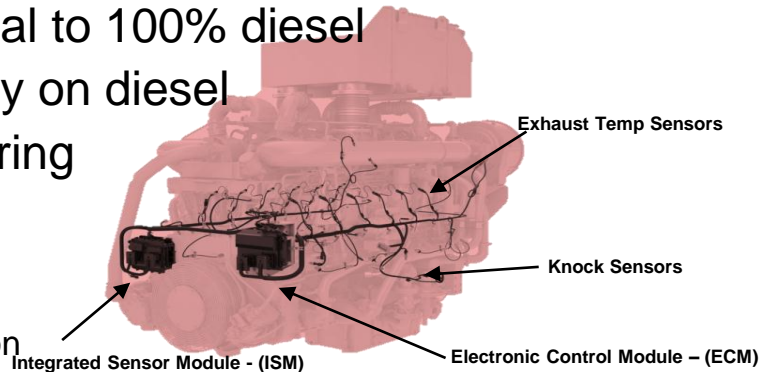
First Full Dual Fuel Fleet Operating in the US



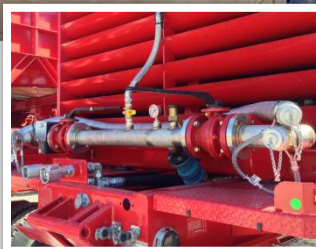
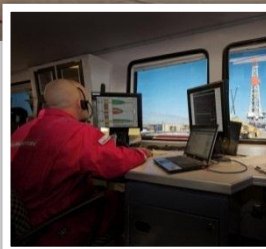
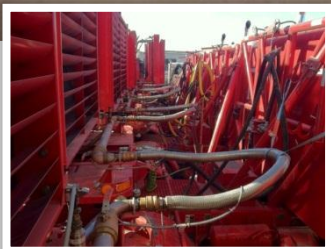
- HAL leads the market with most spreads deployed throughout North America
- Full spreads running on LNG and conditioned field gas
- 70% natural gas substitution

System Features

- Maximum gas substitution
 - OEM = 70%
- Proven ability to run 14 units at full substitution
- Quick rig-up/rig-down system
 - Out of the red zone
- Performance equal to 100% diesel
- Recovers instantly on diesel
- Real-time monitoring
 - Gas flow
 - Gas temp
 - Gas Pressure
 - Percent substitution
- Post job reporting
 - Percent substitution
 - Gas consumption



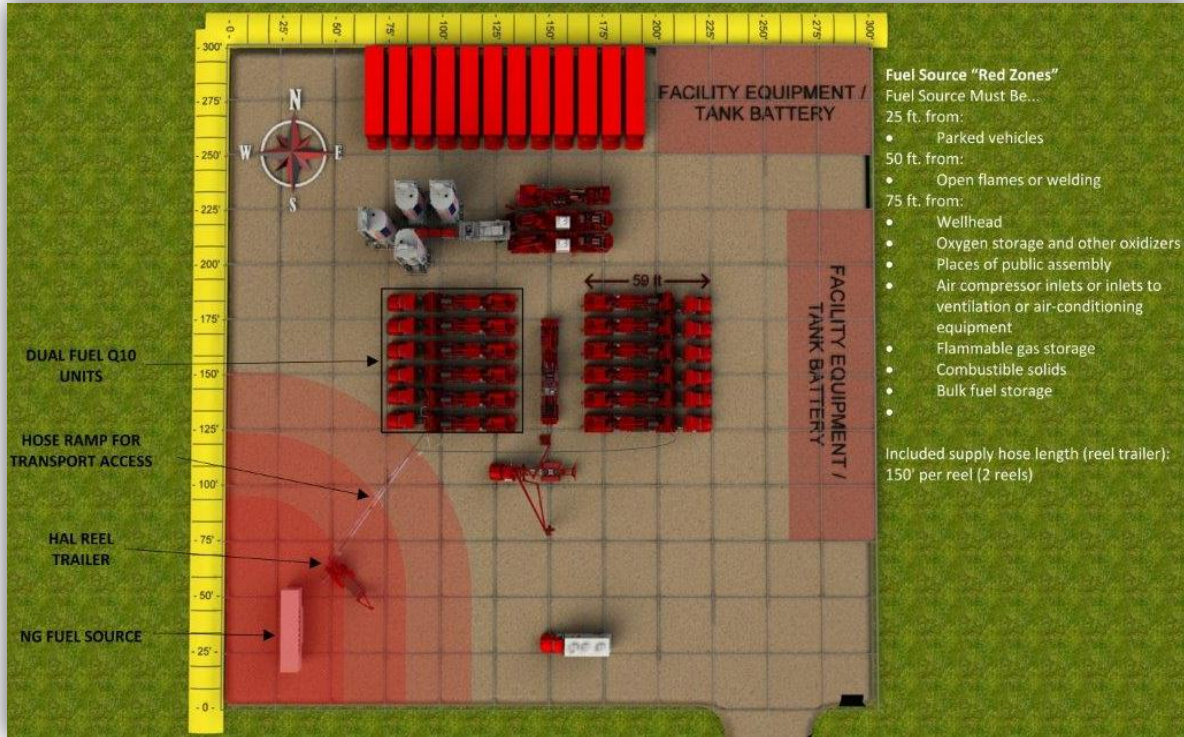
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Planning

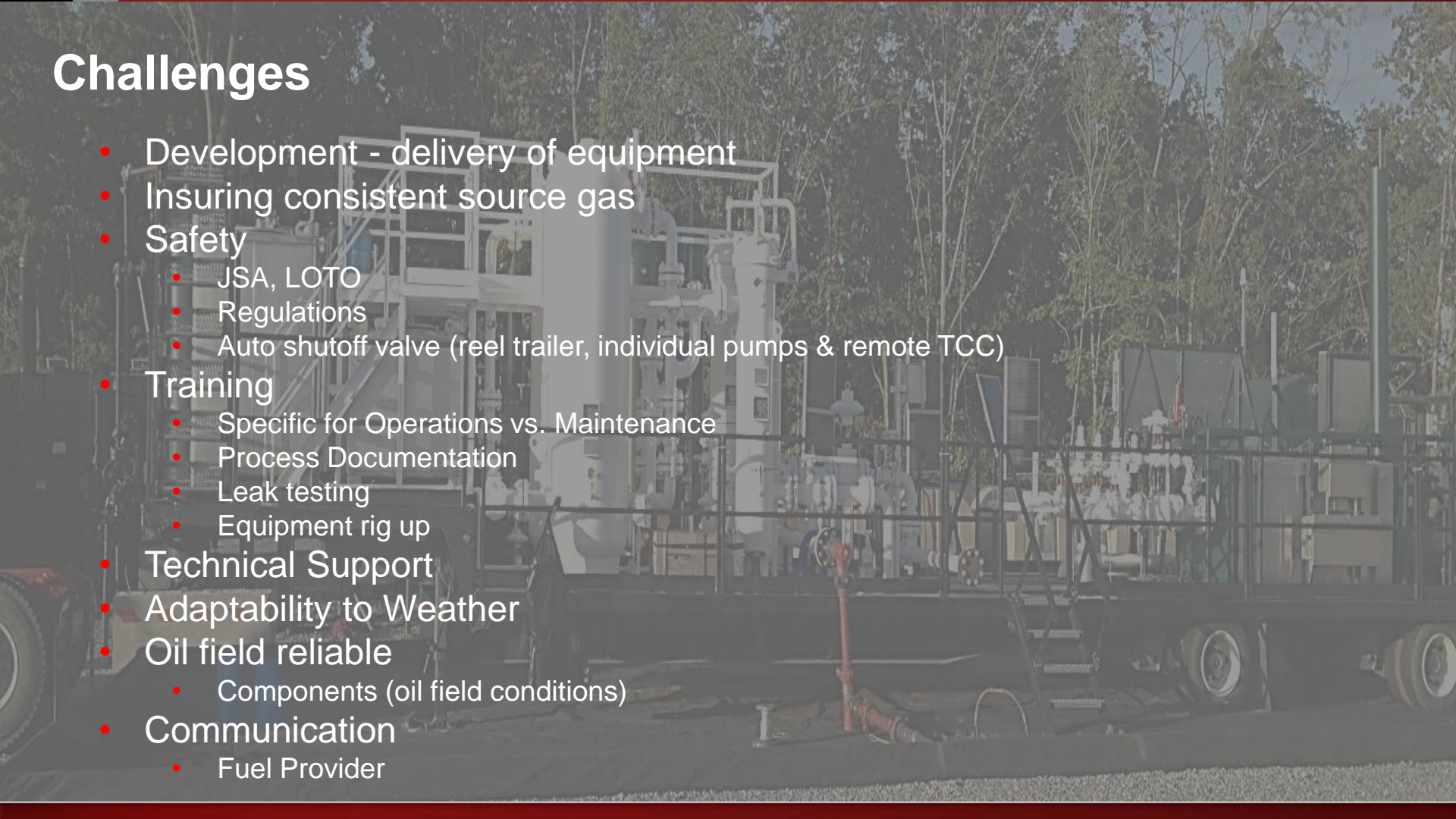
- Gas supply review
 - Specialized software
 - Connection ANSI 3" 150 Flange
 - Supply < 100 psi
- Job planning/timing discussion
- Job layout/site review
 - Space
- Crew training
- Detailed coordination
 - HAL, customer, gas supplier (if applicable)

Sample Dual Fuel Job Planning Layout

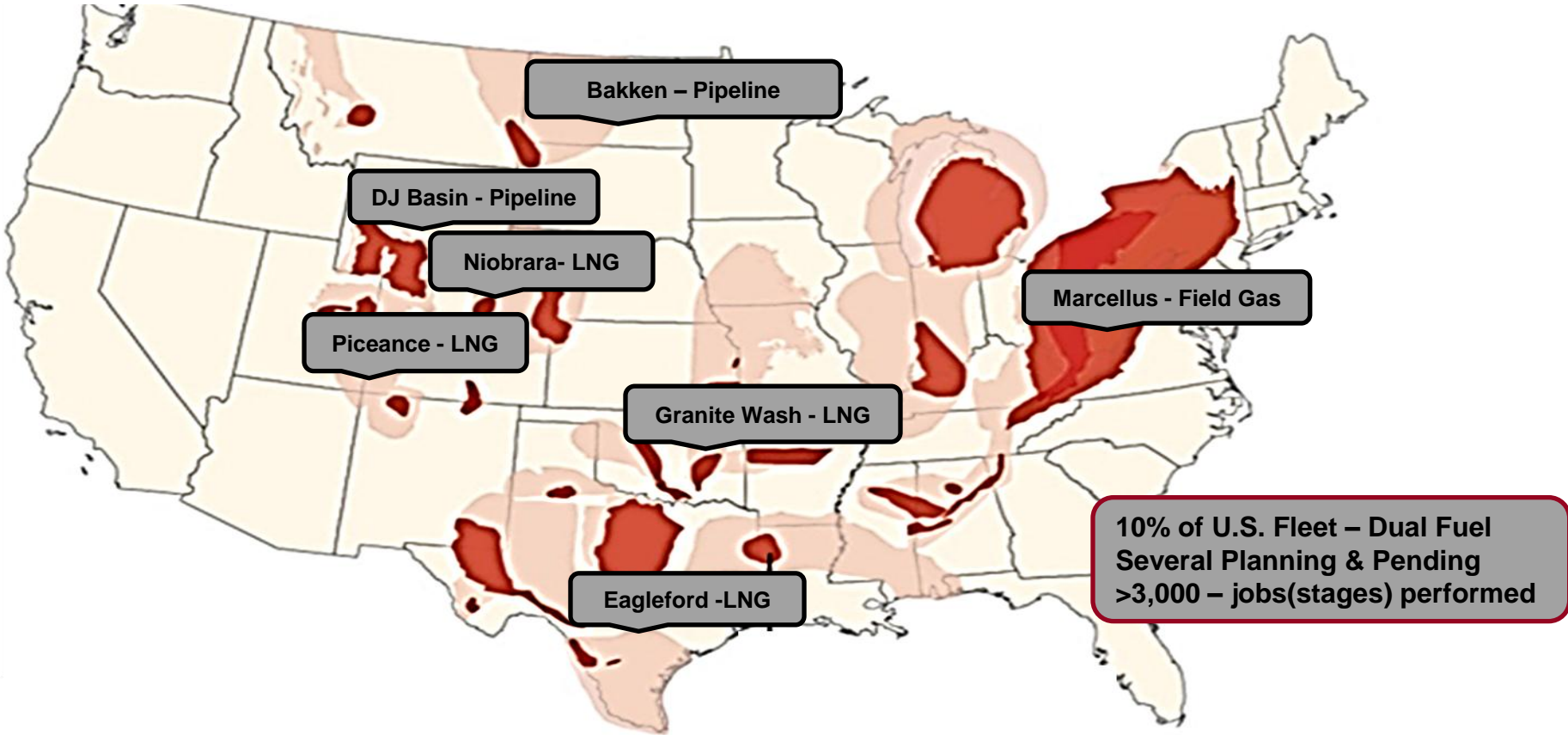


Challenges

- Development - delivery of equipment
- Insuring consistent source gas
- Safety
 - JSA, LOTO
 - Regulations
 - Auto shutoff valve (reel trailer, individual pumps & remote TCC)
- Training
 - Specific for Operations vs. Maintenance
 - Process Documentation
 - Leak testing
 - Equipment rig up
- Technical Support
- Adaptability to Weather
- Oil field reliable
 - Components (oil field conditions)
- Communication
 - Fuel Provider



Halliburton Dual Fuel Fleets



A photograph of an offshore oil rig under construction. Two large, white, cylindrical modules are being lifted by a crane. The rig is situated on a grassy hill. The sky is clear blue.

Thank you.